PSE&G Public Service Electric and Gas Company

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Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, MD 20014

Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch 1
Division of Licensing

Gentlemen:

PWR MODERATOR DILUTION
NO. 1 UNIT
SALEM NUCLEAR GENERATING STATION
DOCKET NO. 50-~~727~~ 272

As committed in our October 5, 1981 submittal, this letter transmits to you, in its enclosure, the results of the analysis undertaken to identify the potential for an inadvertent boron dilution in the Reactor Coolant System. Credible causes of such an event were analyzed to determine the potential for occurrence and their overall implications.

Should you have any questions in this regard, do not hesitate to contact us.

Very truly yours,

E. A. Liden, Manager
Nuclear Licensing and Regulation

FAM:srd

CC: Mr. Leif Norrholm
Senior Resident Inspector
Mr. Gary C. Meyer
Licensing Project Manager

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The Energy People

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SAFETY EVALUATION OF THE POSSIBLE CAUSES AND EFFECTS OF AN INADVERTENT BORON DILUTION OF THE REACTOR COOLANT SYSTEM

I. DISCUSSION:

A thorough analysis was conducted on the Chemical and Volume Control System (CVCS) and all other interconnecting systems at all modes of reactor operation. Attention was directed towards identification of possible paths for an inadvertent boron dilution of the Reactor Coolant System (RCS) to occur. Each path was analyzed as to the required modes of failure, if any, and the likelihood of occurence.

Tube failures of all heat exchangers located in the CVCS and other interconnecting (RHR, SI, etc.) systems was one area of evaluation. It was found that the Seal Water Heat Exchanger has seal water return flowing at a lower pressure than that of the cooling water, component cooling. A postulated mode of a failure for this heat exchanger was a single tube failure. Should this occur the total quantity of clean component cooling water leaking into the RCS would not cause a sharp drop in boron concentration, thereby initiating a sudden increase in reactivity. The low level alarm in the component cooling surge tank or high level of chromates in the RCS would notify the operators of the problem. A total tube rupture was considered to be extremely unlikely and was not evaluated. All other heat exchangers are designed such that the primary system pressure is greater than the cooling water system pressure, thus precluding the above situation from occurring.

A second possible path was primary water entering the CVC system while flushing resins from the Ion Exchange Demineralizers. This process involves a total of 600-1,000 gallons of primary water to be flushed with spent resins to the spent resin storage tank. The only possible path of entry of primary water into the CVCS would be due to a failure to close of the process outlet valve located in the discharge line of each demineralizer. CVCS pressure at this point is slightly less than that of the primary system pressure. The majority of primary water used to flush the spent resin would, therefore, flow through the demineralizers to the spent resin storage tank (this being the path of least resistance). The amount of primary water capable of entering the CVCS would be a small percentage of the total available volume of water. In order to postulate the worst possible case it was assumed that all 1,000 gallons enter the CVCS via the letdown line flowing to the Volume Control Tank (VCT). The amount of primary water flowing into the VCT depends upon the existing level in the tank. A three way valve diverts letdown flow to the CVCS hold-up tanks on high level signals in the VCT. The portion of water flowing into the VCT enters as a spray mixing with approximately 1,000-2,000 gallons of borated water present in the tank. One charging pump normally takes suction from the VCT to provide water for charging and for RCP Seals. Total charging flow into the RCS runs as high as 100 gpm. This enters via the Reactor Coolant Pump Seals (20 gpm for all four pumps) and through the charging line to the RCS (55-80 gpm). Therefore, a situation could occur where there is 100 gpm of primary water entering the RCS. In order for this to occur, all 1,000 gallons of primary water must flow into the VCT with a minimum amount of mixing with the borated water already present. The probability of this occurring is extremely low. Nevertheless, if indeed the situation did arise in which 100 gpm of primary water was entering the RCS for a period of around 10 minutes and mixing with an approximate volume of 94,000 gallons of borated water the probability of an inadvertent boron dilution is minimal.

The reactor makeup portion of the CVCS was also reviewed. This area is addressed in the FSAR under Uncontrolled Boron Dilution, Section 14.1.4. This system is designed to limit the boron dilution rate such that under various postulated failures, indication through instrumentation and alarms provide sufficient time for the operator to correct the situation. It should also be noted that the boron dilution procedure is one that is carried out under very strict administrative controls and also must adhere to the technical specification. Review of this portion of the CVCS did not uncover any postulated paths for inadvertent boron dilution that could not be corrected by operator action in a safe and orderly manner.

A limited boron dilution incident occurred at another operating PWR facility due to the injection of NaOH while the reactor was in a cold shutdown condition (reference 1). While performing surveillance testing of the NaOH tank isolation valves, a portion of the tank's contents drained into the RHR system. PSE&G provided confirmation that the design of the RHR system at Salem precluded the above accident from occurring (reference 2).

PSE&G was notified by Westinghouse of their concerns and recommended actions regarding the potential for an inadvertent boron dilution event at cold or hot shutdown conditions while on the RHR system (references 3 & 4). These recommendations have been adopted. A shutdown margin of at least 5% is maintained when less than or equal to 350°F while on RHR. Recently, Salem experienced an inadvertent dilution of the RCS to less than the 2000 ppm minimum boron concentration required by Technical Specification 3.9.1 (reference 5). This occurred while the RCS was drained to approximately one-half loop level and a hydrolazer was being used to decontaminate the steam generator channel heads. Water was entering the RCS due to the inability of the hydrolazer suction connection to remove all of the scattered spent spray water. A routine Reactor Coolant Boron sample notified the operators of the problem and the RCS was borated to within specifications. Procedures have since been revised such that additional safeguards are present to prevent the above situation from occurring. Measures have been taken to sample on a much more frequent basis and to constantly keep the reactor operators aware that hydrolazing is going on.

Westinghouse has provided a description of a new boron protection system developed in response to additional requirements imposed by the NRC. This protection system uses a source range instrumentation system to detect a reactivity increase due to a dilution while the reactor is subcritical. In addition to this, an automated means of detecting and terminating an inadvertent boron dilution is provided. PSE&G plans to review the system as soon as it becomes available from Westinghouse. If our review indicates that the system provides an added margin of safety against the occurrence of an inadvertent boron dilution, then it will be incorporated at Salem.

II. CONCLUSION

Careful consideration has been exercised in examining possible scenarios for an inadvertent boron dilution of the RCS. This safety evaluation has assessed the likelihood of each scenario and has also examined past cases where an inadvertent boron dilution occurred. It is concluded that the scenarios evaluated do not contain any adverse safety implications with regard to an inadvertent boron dilution at Salem.

III. REFERENCES

1. NRC Letter, G. Lear, to F. P. Librizzi, PSE&G, dated September 19, 1977.

2. PSE&G Letter, F. P. Librizzi, to G. Lear, NRC, dated February 1, 1978.

3. Westinghouse Letter No. PSE-80-48, dated July 9, 1980.

4. Westinghouse Letter No. PSE-80-49, dated July 15, 1980.

5. PSE&G Letter - Reportable Occurance 80-53/03-1, R. A. Uderitz to Boyce H. Grier, NRC dated March 17, 1981.

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